Chapter 1

Bringing Liquidity to Life: Markets for Ecosystem Services and the New Political Economy of Extinction.

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Abstract

This chapter attempts to situate the rise of market-based conservation policy, and its associated theoretical and policy frameworks such The Economics of Biodiversity and Ecosystem Services within a wider history of what might be termed financialisation. Outlining a new chapter in the long history of ontological adjustment of ecological science to dominant accounts of political economy, this chapter explores the emergence of a novel political economy of extinction. This can be analysed in the transformations of theory: the reframing of the sixth extinction crisis within the neoliberal idiom of 'natural capital' and 'ecosystem services' reflects a history of the reprocessing of political and scientific ecological discourse in order to better accommodate it to reigning economic doctrines. TEEB and other articulations of market-based conservation do little to question the dominant economic theory that has licensed the financialisation of social, political and economic life and led to our current global economic crisis. As a species of power, it can also be analysed in the social connections of the corporate boardroom: where the professional authority, executive expertise, epistemic frameworks and political projects of senior conservation ecologists increasingly converge with those of the worlds most powerful bankers.

Introduction

While the people of the world financial centres in the United States, Europe and Japan continue to meander through the strange aftermath of the Wall St financial crisis of 2008, their economies shedding employment and accumulating immense quantities of central bank liquidity and public debt, the biosphere is in negative growth territory, continually being reduced in size, diversity and complexity. In the material world of the 'real economy; deforestation, land clearing and the mining of oceanic fisheries continues apace. Greenhouse emissions continue their exponential rise, and climate change threatens to unravel abiding biotic relationships in existing refugia.

Coral reefs, 'the rainforests of the sea' are so threatened by warming events and ocean acidification that some marine scientists are calling for the rapid upscaling of a raft of prophylactic ocean-engineering technologies. These range from covering vast areas of the reef with giant pool covers, to capturing and re-releasing reef species after genetically engineering them to tolerate heat and acidity stress beyond the range to which they are evolved to withstand (Rau et al 2012). While estimating and predicting rates of extinctions is a dark art, biologists estimate that the irreversible consignment of species to extinction is now occurring at somewhere between 100 and 10000 times the 'normal' deep time rate (May et al. 1995; Pimm & Raven 2000; Lawton & May 2008). In the deep geological time of evolutionary history, the biosphere finds itself on the precipice of the sixth mass extinction crisis since life emerged (Barnosky et al 2011).

The biopolitical project of the 'crisis disicipline' of conservation biology (Soule 1985: 727) once proceeeded on an ethical ground opposed to the heedless destruction of forms of life. The ethics of intrinsic value, in which life-forms exist of themselves and for themselves independent of human meaning systems, was married to the quest for meticulously value-free scientific account of the parts and wholes of biotic communities and ecological system: a rigorously non-anthropocentric ethos and episteme: the better to preserve the extra-economic fundament of life from the depredations of 'the economy'. As is widely recognised, attempts to reduce the gathering pace of extinction have failed under the aegis of the 1992 Convention on Biological Diversity and the ethos of the protected areas paradigm (Butchart et al 2010). While only the most naïve idealists would interpret this as a pure failure of philosophy, a sense of pragmatic inevitability has pervaded the transformation of conservation politics by the inexorable rise of the concept of 'ecosystem services' to the influential heights of international policymaking over the last decde. A now familiar revolution has occurred within conservation biology and institutional practices,a move to fully integrate it with the *sine qua non* of anthropocentric policy languages, margnialist economics as reconfigured by the political philosophy of neoliberalism. As the realisation slowly dawns that ecological erosion in lockstep with climate change, of which it is both cause and effect, will fundamentally threaten the lifeworld of human populations, so too does the knowledge that it is too late for conservation alone, systematic restoration must also be undertaken to re-connect eroding and isolated remnants of the relatively 'wild' biosphere. Yet because the return to ecological pasts implied by 'conservation' and 'restoration' is, given the cumulative irreversibility of extinctions and global warming, strictly impossible, the shift in focus becomes the ethically agnostic problem of re-engineering the resilience of the directly economic functions of ecosystems, for example, the loss of crop pollination through the 'colony collapse disorder' confronting bee populations worldwide.

The shift in the philosophy of extinction accomplished by these developments is marked: the biosphere is no longer to be protected from the depredations of the unlimited economic growth, to be allowed to 'let live' in a separate, delimited space and a sphere of values, as in the protected areas paradigm, or in the theoretically unlimited (but politically neutralized) sovereign protection of the US Endangered Species legislation. As Australian Environment Minister Peter Garrett put it in a (2009) speech to conservation professionals,

> With 1,750 species on the threatened list it is time Australian governments began to deal with regional ecosystems rather than adopting a band-aid

> approach to dealing with species under stress […] While […] we'll have to act in an urgent way from time to time to prevent their extinction, it won't always be effective to keep tackling them one by one. We shouldn't focus solely on the sick and dying, but should work to build the resilience of ecosystems and landscapes, to ensure, if you like, that the hospital waiting rooms are a little less full and the health care a lot more preventative.

Perhaps nothing signifies what is at stake more clearly than the name of the CBD's new transnational scientific institute, dedicated to collating, analysing and advancing state of the art scientific knowledge to inform the political community: the International Platform on Biodiversity and Ecosystem Services (IPBES). The model organisation for this is of course the IPCC, which in its quest to communicate state-of the-art climate science, did not think to pre-empt neoliberal styles of thought by dubbing itself the 'International Panel on Climate Services'. In the same move that reconstitutes nature as a form of capital that will yield us interest in the form of 'ecosystem services', the market comes to be naturalised.

What remains of the 'wild type' biosphere, and indeed all of its utilitarian effects (rainfall, flood mitigation, crop pollination) are to be properly evaluated and fully internalized inside the economy by becoming monetized, capitalized, and traded as 'vital infrastructure assets'. On the ground, private and state actors are fostering a host of experimental biodiversity banks, markets for various ecosystems services and for biodiversity 'offsets', and development projects involving payments for ecosystem services. At the level of the United Nations, this has culminated in theoretical attempts to codify 'The Economics of Ecosystems and Biodiversity' (TEEB) (Sukhdev 2010, Kumar 2010, ten Brink 2011, Bishop 2012).

The rise of 'ecosystem services' has been accompanied by an immense mushroom-shaped literature across the grey literatures of Big Conservation and international policy for a, and the journals of conservation biology and ecological economics where has wide if often uneasy professional acceptance in these areas. Certainly, the problems it seeks to address are serious. How to finance the maintenance of existing biosphere reserves and national parks in the postcolonial South? How denationalised capital flows, and the permanent fiscal crisis of the environmental state brought on by structural adjustment, and the need to export primary commodities to service debt. How to re-establish habitat connectivity between the isolated islands of 'biosphere reserves' across landscapes privately owned and dedicated to economic production, without a massive program of land nationalisation? Who among us would not hope to witness, after a bit of microcredit and 'social innovation', a flourishing of small, medium and large conservation providers, the rise of a productive sector specialising in large scale ecological restoration and long-term prudential ecological management. It would be wonderful to live in a world where it was so profitable to nurture the well being of the biotic community that 'providers' of 'ecological services' could outbid coal miners for land containing coal.

In order to counter this sentimental utopia, this chapter seeks to situate the rise of the 'economics of biodiversity and ecosystem services' within a wider history of 'financialisation'. Concisely, the term financialisation refers to the "process whereby financial services, broadly construed, take over the dominant economic, cultural, and political role in a national economy" (Phillips, 2008). This process of course, is a global one, insofar as the denationalization and liberalization of finance

has been a continuous project of US foreign policy, IMF structural adjustment policies and WTO treaty making.

In this chapter my critique of 'ecosystem services' is more particularly interested in the fact that this fundamental reframing of the problem of biosphere destruction offers no resistance or critique, and adapts itself quite seamlessly to the currently hegemonic account of financial markets, knowledge and the political derived from the Austrian neoliberal Freidrich von Hayek, and the standard neoclassical economics of permanent growth in equilibrium. Through the concept of 'ecosystem services', the ecological scientist thus risks becoming too well attuned to the neoliberal ontology of nature, knowledge and political morality .

The essence of neoliberalism as a political philosophy is in the social epistemology of the Austrian economist Friedrich Hayek, who struck fast to the view that nature and society are both so complex that only market prices are the only reliable form of collective information gathering, processing and distribution. Its inscrutable 'decisions' on how to organise economic life, even if they seem irrational, cruel and unjust, in fact always surpass the expert knowledge assembled by institutions or scientific organisations, regardless of democratic desires for social justice or other purposes – such as addressing the problem of systemic ecological degradation.

In Hayek's late philosophy, the market is *like* the biosphere, insofar as it is an evolving, non-linear and complex adaptive system that thrives on the emergence of its own catastrophic turbulence, an evolved order too complex and resilient for any centralised from of knowledge to comprehend, much less to predict or control (Walker & Cooper 2011). For Hayek, the Market is the highest level attainable of collectively organised human knowledge, inaccessible to actual humans apart from concise price signals. And yet because we can only know Nature or Society through the information distilled and distributed by our own subjective 'environment' of prices, we can never really know if the biosphere is in crisis, or whether its worth doing something about it, until it is actively traded in private exchange.

The new political economy of extinction represented by ecosystem services, rather reframes the problem in the familiar neoliberal fashion as a 'market failure' that can be traced not to the inherent inappropriateness of private-profit seeking as the solution to particular collective social problems, such as the ecological effects of our current growth-at-all-cost economic system, but rather some political failure to foster the markets autonomous proliferation of novel market formats, property rights and financial instruments (ie. 'financial innovation') in the spirit of the Mont Pelerin Society member and Chicago School economics-law scholar Ronald Coase (1960).

Hayek's prescient portrayal of market prices as distributed information processing (1945) was later to be incorporated into neoclassical finance theory by his Chicago school fellow travellers in the form of the 'efficient markets hypothesis' . The theoretical bases of the idea that our only hope to conserve and restore the biosphere is to have Social integration with Nature mediated and 'self-regulated' by financial market prices, are 'grounded', to use a word inappropriate to in the neoliberal finance theories such as the Efficient Markets Hypothesis (EMH) (Lucas 1972, that numerous analysts have linked to the phenomena of 'financialisation' and the ongoing world economic crisis. Thus it seems to me wholly surprising that a body financial theory that has failed so spectacularly in the sphere of finance, should now be called upon to effect the missing transvaluation of ecological values we so desperately need to prevent 'the economy' taking the biosphere down altogether.

What might the social and political consequences be of seeking to finance conservation and restoration by incorporating the problem of extinction within more or less the same neoliberal economic doctrines that unleashed the current global financial crisis? Is their no better way to reverse mounting ecological despoliation than via a comprehensive financialisation of the biosphere? Whose interest does the financialisation of biodiversity and ecological preservation serve?

In the move to depoliticise conservation by subjecting ecosystems and species life to evaluation by financial markets (in the form of investment and disinvestment) is also a reorientation of the hierarchy of knowledge. Just as the biosphere is to be internalised within economic discourse is one variety of capital (financial capital, industrial capital, social capital, natural capital), so too is ecology to become a subordinate science to the master science of economics. And just as the ecological crisis has not yet falsified the 'human exemptionalist' paradigm in economics, the deepening economic crisis has not yet falsified the mainstream economics of finance, nor has it lead to any political change capable of unseating the financial elite who have, if anything consolidated their financial wealth and political influence in and through the crisis, as governments continues to socialise the speculative losses of private banking firms in the form of mounting government debt, austerity measures, inflationary debt monetisations, central bank purchase of 'toxic assets', mass unemployment, and in the latest twist from Europe, direct raids on ordinary savers bank accounts. Neoliberal politics, it seems, thrives on the very disasters it produces (Klein 2007, Cooper 2008, Pellizoni).

A brief genealogy of ecosystem services

Responding to the 'limits to growth' debate of the 1970s, mainstream economists tended to account for the exhaustion of scarce natural resources – which were presumed to be minerals in almost every case - as 'creative destruction', an opportunity for entrepreneurs to cash in with the next technological *substitution*. In the standard neoclassical model of permanent growth in equilibrium, which denies any direct role for natural resources in economic process, a market economy will always converge towards a steady rate of growth, which depends only on the rate of technological progress and the rate of labor force growth. Putting aside the biophysical challenge to the presumption of infinite industrial expansion (through appeals to the coming fusion reactor), they re-framed the problem as a theoretical inquiry into the market conditions conducive to an 'optimal rate of depletion' (Stiglitz 1974a, 1974b, Dasgupta & Heal 1974, Solow 1974). 'Substitution' has since functioned as a catch all concept to explain away the problem of resource depletion, A common thread in these papers was the conjecture that the real problem was in fact the absence of futures and risk markets for depletable natural resources. As Dasgupta and Heal put it:

> "…many of the difficulties that are involved in the making policy recommendations about the rate of depletion of exhaustible resources stem from the fact that crucial aspects of this problem are inherently uncertain, and it is not clear that an adequate class of contingent markets exists." (1974, 4)

Faced with global ecological risks, the necessity of complete markets – for every conceivable risk, for every 'savage' state of nature – becomes critical: "Everything

depends upon how traders form their expectations about the future in situations where definite information is lacking." (Heal 1974, 1). Other economists confidently predicted that several hundred years hence, the inexorable depletion of minerals and fossil energy would bring about– *mirabile dictu !* - an 'age of infinite substitutability' (Goeller & Weinberg, 1978).

The term *ecosystem services* was coined by publicly-engaged ecologists and conservation biologists in the 1980s (Ehrlich & Ehrlich 1981, Ehrlich & Mooney 1983), as a pedagogical device to try to get across to conventional resource economists the point that neither human life nor 'the economy' could exist without the biosphere in something resembling its present form. As Lovelock (1979) has observed, absent the geo-transforming effects of the biosphere the Earth would have an oxygen-less atmosphere of 98% carbon dioxide, and an annual average temperature of around 290°C.

Redirecting the question of the limitation of 'natural resources' away from minerals and fossil fuels and into the biosphere as background pre-condition for human existence, Erlich and Mooney (1983) argued that certain 'keystone' species, are simply non-substitutable. They are critical as partners in so many symbiotic, mutual relationships across the web of life – food, habitat, pollination, seed dispersal, soil structuring, ecological engineering- that their loss could cascade in a kind of extinction multiplier effect which could degrade and irreversibly alter ecosystems, curtailing their productivity and abundance, ultimately unravelling crucial *ecosystem functions*, like temperature regulation, hydrological cycling, soil formation, the cycling of C, N and P. Extinction events ('losses of biodiversity') are not atomised, discrete events, but themselves time-delayed causes of further local, regional and global extinctions, as recognised in the biogeographical trope of the 'extinction debts' (Tilman, 1994, Malanson 2008). Extinctions cascade cumulatively forward shaping the fundamental conditions of life into a future stretch of evolutionary time completely indifferent to the egoism of that species apt to regard itself as the realisation of the *telos* of life itself.

In one of the earliest papers to introduce the term 'ecosystem services', even before the neologism 'biodiversity' had been coined, the link between extinction and 'human well being' is baldly stated:

"*all* [ecosystem services] will be threatened if the rate of extinctions continues to increase" (*italics in original,* Ehrlich & Ehrlich 1981 cited in Maier 2012, 187).

In practice, this move disclosed a knowledge problem: the precise causal relations between an as yet largely un-taxonomised biological diversity (species richness, genetic diversity, community diversity) and the ecosystem functions that emerge from and condition their existence were under-determined by the classical division of ecology into the taxonomic perspective of the biotic community or the biophysics of the 'ecosystem'. Conservation biologists thus proposed that a rigorous precautionary policy was warranted towards every particular extinction.

Arising from recognition of the lack of clarity as to how species loss might generate changes in global ecosystems, or how biodiversity was related to 'productivity' as modeled by the International Biosphere-Geosphere program (SCOPE 1991), the question has since developed into a whole new subdiscipline in ecology called biodiversity and ecosystem function (BEF) research (Tilman 1994, Naeem et al 1994, Naeem et al 2009). Yet as Simberloff (2003) notes, studies of even the most well documented extinctions, such as disappearance of the sky-

blackening flocks of the passenger pigeon, barely touch the question of the ecological consequences. What if there were, in this and other cases, almost none? Would the entire paradigm of justifiying extinction prevention through the functionalist language of economic self-interest simply evaporate if ecosystem functions could be equally maintained by exotic invasives, or monocultures?

What is particularly interesting in the rise of decision sciences of triage (Bottrill et al 2008, Kareiva and Levin 2003)– given that conservation efforts attract limited funding and must choose which extinction risks to manage - is the sense that each scenario of extinction, bioinvasion or ecosystem destruction can and should be brought into analytical focus and evaluated from the perspective of its functional value as a contributor to a human life support system. Inadequately explored in the immense literature on ecosystem services, is the problem of what happens when ecosystem *functions* as described by ecologists are translated into the entity that economists call *ecosystem services*?

Since the 1980s, ecologists have made serious efforts to work with mainstream economists. This has happened in convocations such as the Beijer Institute of Ecological Economics, and in multiauthored papers that have used 'ecosystem services' as a means to cobble together some common intellectual ground (Arrow et al 1995). One widely discussed paper co-authored by leading BEF ecologists and environmental economists (Costanza et al 1997) estimated the annual monetary value of the biosphere's contribution to human well-being on the order of $US 33 trillion, although most of it was 'outside the market'. Erlich's student Gretchen Daily has been one of the most important popularisers of ecosystem services, (Daily 1997; Daily, Ellison and Myers 2002; Daily et al 2009), supported also by legal specialists (Salzman 2005) and orthodox finance economists (Chichilnisky and Heal). But it was the publication of the UN Millennium Ecosystem Assessment (2005), which adopted the idiom of ecosystem services for its policy framework, that did most to catalyse the mushroom-cloud shaped literature on 'ecosystem services' across journals like *Conservation Biology* and the increasingly mainstream *Ecological Economics*, the 'grey' literatures of governments and natural resource management, big ENGOs as The Nature Conservancy, Conservation International and World Wildlife Fund, global development institutions (UNEP, WB etc), and the transnational networks where scientific and policy-making coalitions are forged (Beijer Institute for Ecological Economics, Stockholm Resilience Centre). In the quest to 'demistify materiality' and 'hardwire biodiversity and ecosystems into finance' (UNEP-FI 2012), numerous experiments involving markets and other systems of payment for 'ecosystem services' are underway (Baggethun et al 2010, Kosoy et al 2008; Koellnor 2008). Along with various 'species banks' (Katoomba Group 2012), there are also a range 'offset' schemes underway, such as the voluntary NSW Biobanking scheme, or the the US market for wetlands, which in theory trades habitat loss against restoration projects under a 'cap and trade' no net loss arrangement. Then there is the global Business and Biodiversity Offsets Programme, initiated by a consortia of mining and logging interests, in an act of voluntary 'self regulation', or public relations.

Given its origins in a plea for the irreplaceability of natural species and communites and the absolute irreversibility of extinction, it is more than a little ironic that 'ecosystem services' has become a technology of security designed to increase the biosphere's 'liquidity' from the point of view of financial markets. By 'securitising' ecological units and processes into financial assets which can be negotiated, exchanged, or substituted on capital markets for cash or other forms of

financial capital (the 'biodiversity offset' for example, which trades an act of present destruction for a promise of ongoing conservation or future restoration) 'extinction debts', which are by definition strictly unpayable can become profitable sites of financial innovation and portfolio investment. But of course it must be remembered that liquidity also presumes the possibility of instantaneous *disinvestment.* In a world where biodiversity protection is to be mediated by global markets for ecosystem services, the process of identifying expendable species via triage becomes not so much a case of the kind of Taylorist scientific analysis of species utility as it does in the BEF literature (Kareiva and Levin 2003), but of rational business decisions to write off unprofitable investments, or in the larger market context, according to the the speculative affect of euphoria or panic that constitutes volatile financial 'market sentiment'.

One consequence is a shift in the site of the determination and execution (or not) of environmental policy to the boardrooms of transnational corporations, and a privatisation of increasingly scarce ecological health.

Financialistion: a cautionary tale

It seems worthwhile to note that key actors involved in the push to reframe ecological protection, conservation and restoration as financially profitable business activities are also people who have senior roles in the global investment banks at the centre of the financial crisis. While the ecosystem services literature often claims to be merely providing a means to evaluate nature in land use decisions, the logical extension of the strange idea that 'nature has to pay for itself' (Daily & Ellison 2002) is the project to transform the worlds ecosystems into natural capital assets capable of yielding flows of 'services' that can be privatised, securitised, and profitably traded in global financial markets (Chichilnisky & Heal 1998, 2000). The risk of extinction and ecological meltdown is What is at stake in the effort to construct a global market in ecosystems services, in the transformation of the figure of the conservationist from a woolly naturalist to a consummate banking insider? This transfiguration is complete in the person of Pavan Sukhdev, the leader of the UNEP Green Economy initiative and its project to codify The Economics of Ecosystems and Biodiversity. An international career banker and financial 'innovator', Sukhdev's credentials include having:

> worked with Deutsche Bank for 14 years. [..] While at Deutsche Bank in India, Pavan founded and later chaired [the] Global Markets Centre, Mumbai "[…] It is being used by Deutsche Bank's originations, derivatives structuring, trading and distribution teams in equities, credit, fixed income and foreign exchange around the globe. (UNEP bio)

An eloquent activist for the cause of the mainstreaming biodiversity and ecosystem erosion, Sukhdev was a key figure in the successive rounds of liberalisation of Indian financial markets "instrumental in the evolution of India's currency and interest rate and derivatives markets from 1993 till 1998. He was a member of several Reserve Bank of India committees for the development of India's financial markets, including the Sodhani Committee on Foreign Exchange Markets. More recently, he has chaired the World Economic Forum's 'Global Agenda Council on Ecosystems & Biodiversity,

and currently serves on the boards of Conservation International and the Stockholm Resilience Centre.

The purpose of TEEB is to internalise the economic values of Nature into decision making at all levels using market pricing (TEEB, 2010: 3, 14; Spash and Aslasken 2012). The Synthesis Report indicates that TEEB intends:

> "creating a common language for policymakers, business and society that enables the real value of natural capital, and the flows of services it provides, to become visible and be mainstreamed in decision making". (TEEB, 2010 p.24)

We learn about the form of this common language in *Ecological and Economic Foundations* (Pushpam 2010), the key theoretical book in the TEEB series:

> "In economics, 'value' is always associated with trade-offs - that is something only has (economic) value if we are willing to give up something in order to get or enjoy it. The common metric in economics is monetary valuation..."

As Spash and Aslucken (2012) understand, TEEB is congruent with a philosophy in which corporations can do no wrong.

> "TEEB employs the political rhetoric of "getting the price right" to allow markets to function efficiently. This involves explaining that, waste sinks have no cost for the private sector, and non-market benefits provide no reward to the market investor. In this neo-liberal framing private companies that destroy and pollute are innocent victims of a failing price system and cannot be blamed because they lack the right incentives for ecologically sustainable management. So we are told that, "Companies do not clear-cut forests out of wanton destructiveness or stupidity. On the whole, they do so because market signals [...] make it a logical and profitable thing to do" (TEEB, 2010 p.9)"

To give an example of the risks of financialisation, we might look at the food crisis that broke in the period 2007 -2008, when the global prices of basic food commodities - rice, maize and wheat - soared amid an unprecedented amplification of volatility in the worlds grain markets. Rice for example, almost tripled in price between March 2006 and the peak of the spike in May 2008.

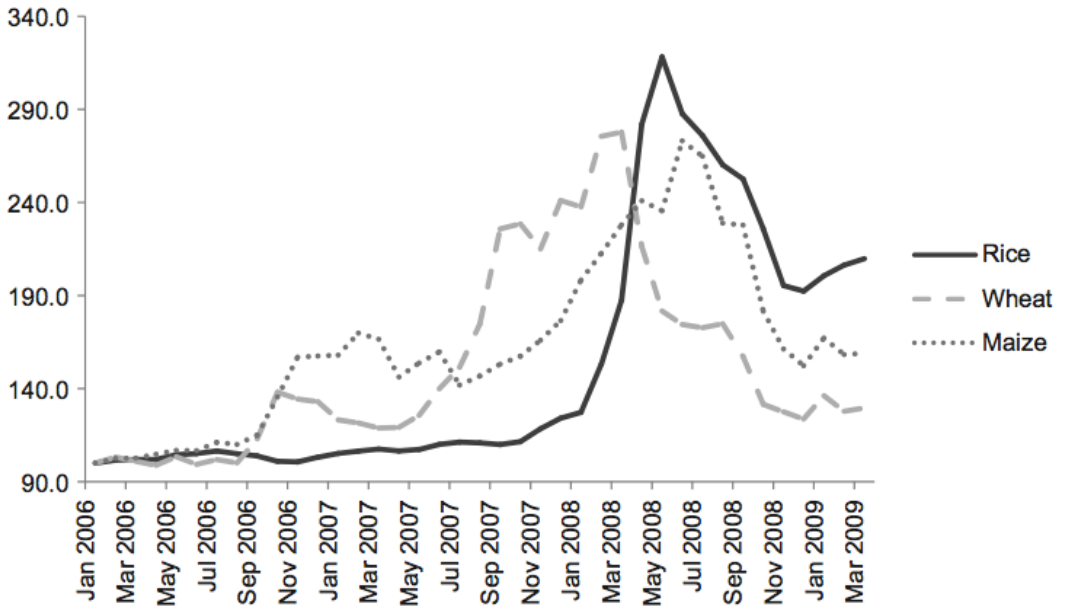

Figure 1 Index numbers of world trade prices of food grains (Source: Ghosh 2010: 76)

Millions of poor worldwide, accustomed to spending much of their income on food staples, were immediately thrust into destitution and hunger. According to one estimate, of the roughly 2-billion people across the world who spend more than 50 percent of their income on food, 250 million people joined the ranks of the hungry in 2008, bringing the total of the world's "food insecure" to a peak of 1 billion people (Kaufman 2011). Food riots broke out from Haiti to Cairo, and social unrest simmered. As the whole sale price eased, Northern media attention turned to the stunning collapse of Wall St banks in September 2008 and the *Götterdämmerung* of Bush administration bailing out the banks at the centre of the roiling the global financial markets. Even after grain prices eased on world markets, prices did not fall in numerous local and national contexts in the South, restricting the poor from accessing food with varying degrees of intensity.

Noting that grain production continued to keep up with grain consumption, economists, and that prices of local millets and other grains not traded in world futures markets did not rise, the Indian economist Jayati Ghosh isolated the seismic price shifts and ongoing rise in food prices to the generation of a highly profitable price bubble as hedge funds and investment banks, including Deutsche Bank and Goldman Saches piled into staple food futures markets, which had been deregulated in 1999 in the US by the Commodities Futures Trading Commission (Ghosh 2010). Billion dollar bets on price rises become a self-fulfilling prophecy. Olivier De Schutter (2011), UN Special Rapporteur on food security has linked the financialisation of food markets to the global land grab that is driving up the price of land rights in many Southern contexts, especially Africa, pushing local farmers off the land in favour of transnational exports to the countries with surplus $US dollar holdings and inadequate long-term food security, such as China and Saudi Arabia.

It is not incidental, I think, that the most influential advocates of market-based environmental policy are to be found amongst the financial elites that

benefitted handsomely from the dismantling of Depression-era banking law and public interest legislation, such as the 1933 Glass-Steagall Act. Repealed under pressure from Wall St lobbyists and neoliberal economists, these reforms had for generations, at least in the West, effectively minimised the situation J. M. Keynes had described in the *General Theory*:

> "Speculators may do no harm as bubbles on a steady stream of enterprise. But the position is serious when enterprise becomes the bubble on a whirlpool of speculation. When the capital development of a country becomes a by-product of the activities of a casino, the job is likely to be ill-done." (Keynes, [1936] 2009: 142)

Since our concern is the capital development of the biosphere as such, the stakes are very indeed. What are we to think of this new political economy of extinction, in which in which endangered species will not only be evaluated as superfluous to human needs by functional sciences, but will be invested in according to profit or 'shorted' to extinction in accordance with the ultra-short term investment horizon of speculative finance? Can the eco-warrior really resolve into the figure of the biodiversity banker (Lambe, 2007)?

Highly Connected: Complex Hierarchies in the Financial Ecosystem

In this section we step into the habitat of some of the senior ecologists and bankers engaged in articulating an economics of biodiversity and ecosystem services. It turns out that while on the one hand bankers such as Pavan Sukhdev are conceiving of a comprehensive suite of financial markets for ecosystems, there is also a coterie of senior ecologists engaged in applying cutting edge ecological theory to the analysis of systemic financial risk.

While the two projects are yet to be explicitly articulated, it is fascinating that they form an inverted mirror of one another in which the biosphere and global finance markets are to be conflated through the collapse of science metaphors into ontology. If the markets for ecosystem services literature ultimately offers financialisation as the solution to the biodiversity crisis, the emergence of an epistemology of finance as a complex ecosystem in far-from-equilibrium conditions effectively naturalises the ongoing financial crisis, obscuring its political origins and effects by locating not in the social categories of political economy but in the grand temporality of evolutionary biology and the functionalist terminology of second-order systems theory.

The mainstream economics profession has tended to adopt a position of defensiveness and radical innocence with regard to its intellectual complicity in authorizing runaway financialisation (Mirowski 2013), the post-crisis debate has nevertheless catalyzed a reappraisal of the neoclassical presumptions of perfect information, infinite foresight, instantaneous and frictionless returns to equilibrium after exogenous shocks, complete markets and risk-free financial contracts, linear predictability and the utter uniformity of the representative agent, assumptions programmed into the computable Dynamic Stochastic General Equilibrium model, which became a mainstay of government and central bank policy making prior to the crisis. The GFC has brought to the fore a movement which seeks not to provide a radically alternative policy analysis, but to rather to extend and complete the refound the ontology of finance and macroeconomics away from the pale imitation

of Newtonian physics, to bring financial economics into conformity with developments in the science of biological complexity.

In 2009, Andrew Haldane, the Bank of England's Executive Director of Financial Stability, argued for the integration of complex systems theory (particularly as developed in the field of ecosystems science) into the toolkit of financial regulation. Haldane's commitment was mentored by the veteran systems ecologist Robert May, himself an official scientific advisor to the Bank. Unfolding the logic of connectivity that is a familiar feature of complexity theory, Haldane highlighted the parallels between the contagion effects of infectious disease, the accumulation of 'extinction debts', and the potentially systemic effects of bank failures occurring in critical nodes of the global financial markets:

> Both events [the failure of Lehman Brothers and the unfolding of the SARS epidemic] were manifestations of the behavior under stress of a complex, adaptive network. Complex because these networks were a cat's-cradle of interconnections, financial and non-financial. Adaptive because behavior in these networks was driven by interactions between optimizing, but confused, agents. Seizures in the electricity grid, degradation of ecosystems, the spread of epidemics and the disintegration of the financial system each is essentially a different branch of the same network family tree. (Haldane 2009)

Haldane went on to suggest that regulators should abandon the general equilibrium models of orthodox economics and instead 'rethink the financial network as a complex adaptive system' characterized by non-linear dynamics and susceptible to sudden changes of phase state or so-called 'tipping point' during periods of stress.
Shortly before he delivered his speech, a group of senior ecologists including Robert May Simon Levin, and George Sugihara published a paper in *Nature* which outlined the usefulness of complex systems ecology as a model for bankers during the gathering sub-prime crisis (May, Levin & Sugihara 2008). This paper had its origins in a conference sponsored by the US Federal Reserve to explore New Directions for Understanding Systemic Risk, which brought together the insights of financial risk managers and systems theorists from the natural sciences to explore the hypothesis that '[t]he notion of systemic risk in the financial system bears a strong resemblance to the dynamics of many complex adaptive systems in the physical worlds', concluding '[t]he commonality of stability and resilience to shocks in complex systems suggests that approaches to risk management in natural and physical systems could be pertinent to financial risk management' (Kambhu et al. 2007, 56, 7). Key speakers included Timothy Geithner, later to replace Hank Paulson as US Secretary of Treasury supervising the bailout of Wall Street, and the ecologists Simon Levin and George Sugihara. What is distinctive about the interventions of Andrew Haldane and others is the fact that the ontological refounding of financial economics in complex systems theory no longer functions for them as an argument against regulation per se, as it did for Hayek, but as the starting point for a wholesale reformulation of financial risk management itself, involving the systematic introduction of non-predictive, futurological methods of vulnerability analysis such as scenario planning. In the words of Nout Wellink (2009), chairman of the Basel Committee on Banking Supervision, 'the goal of regulatory changes should not be to decrease complexity per se' nor to return to the financial regulations of the past, but to make complexity 'more manageable' by constraining systemic risk, and improving the 'resilience' of the financial system as a whole.

The career of the marine ecologist George Sugihara personifies the

increasingly seamless epistemic integration of financial and ecological risk analysis at issue in this article, and the professional convergence of the conservation biologist with the figure of the financial innovator. An expert in the population modelling of plankton and fisheries as chaotic, complex systems, Sugihara was "seduced" in the mid-1990s by Deutsche Bank, at a time when investment houses were hiring ex-Cold War 'rocket scientists' and biologists with mathematical modeling skills at the cutting edge of science, compared to those of your average economist (Dalton, 2005). After several years in their derivatives arm working on a secret 'black-box project' to develop novel instruments and trading strategies, he returned to the Scripps Institute of Oceanography, where he began work on a project to set up market to conserve fisheries by allowing fishers to profit from trade in futures and options and catch rights. Fish markets are subject to large volatilities of price and catch volume, offering ideal conditions for derivative trading which thrives on critical events. His outline of derivative contracts for such an exchange are, quite fittingly for the privatised knowledge technologies of financial innovation, the subject of patent applications.

Peter Kareiva, the respected ecologist whose name we recognize from the BEF literature, is currently head scientist of The Nature Conservancy (TNC), and an author of the methodology of ecosystem services valuation developed by the Natural Capital Project. The acronym 'TNC' aptly symbolizes the transnational reach and corporate organisation of the Big Three conservation NGOs (the other two being Conservational International and World Wildlife Fund) which since the mid-1980s, a period widely noted for the drying up of conservation funds, have come to control perhaps a half of the finance available for conservation globally (Chapin, 2010) Notably, it was during the 1980s Third World Debt crisis, which precipitated a rapid increase in the rate of deforestation in the tropics, as IMF 'structural adjustment' programs replaced import substitution with 'export led development' and fiscal contraction, that conservation NGOs such as World Wildlife Fund, Conservation International and the Nature Conservancy gained international high finance experience in the form of the 'debt for nature swap', buying out portions of 'distressed' sovereign debt on secondary markets in exchange for commitments to fund protected areas (Reilly 2006).

Self-described prior to the sub-prime crisis as 'Nature's Real Estate Company', TNC eschews the environmentalist role of public policy critique in favour of the private bequest and purchase of land for conservation corridors and easements. While the effectiveness of this global effort are beyond our present concerns, TNC has been accused of not being above some environmentally questionable land speculation in a series of articles in the *New York Times*, of allowing oil drilling on donated land, and of involvement in the Bush era Pombo/Inhofe rewrite of the Endangered Species Act, which introduced economic criteria into the process of listing endangered species and devolved enforcement from the EPA to an assortment of local agencies. Academic scientists such as Kareiva and Gretchen Daily are well outnumbered on the TNC Board, which includes senior executives from the 'keystone' predators of the global finance ecosystem: the hedge fund Blackstone, Barclays Bank, Goldman Sachs. The Conservancy's current CEO, Mark Tercel, was previously the executive responsible for the Goldman Sachs Centre for Environmental Markets. And while it declines to publish the names of its thousands of corporate donors, the advisory 'Business Council' listed on the Conservancy's website includes: ExxonMobil, Dow Chemical, Duke Energy, Weyerhauser, Monsanto. This is a roll call of corporations who are significant opponents of

environmental law, and also funders of low-brow counter-science campaigns through neoliberal 'thinktanks'. As Naomi Klein (2013) has noted, that Conservational International and TNC invest considerable portions of their substantial funds directly in the fossil fuel sector, which does seem something of an ethical contradiction. The transformation of TNC from a local conservation association to a TNC can be thought of in terms of the three-phase neoliberal think tank strategy, which has establishes the terms of acceptable political debate on climate policy by advocating simultaneously, but from different quarters: [1] science denialism, [2] financialisation and [3] geoengineering as the only acceptable 'market based' approaches to the crisis of the biosphere (Mirowski, Walker & Abboud 2013).

For our purposes, perhaps the most illustrious political insider and figure of neoliberal conservation is the billionaire Hank Paulson, who prior to his fateful appointment by President G.W. Bush as US Secretary of Treasury, served simultaneously as CEO of Goldman Sachs and Chair of The Nature Conservancy Board. It is in this capacity that he wrote:

> "[...] It is is clear that a system of market-based conservation finance is vital to the future of environmental conservation." (cited in Levitt, 2005)

Three years later, in a move antithetical to the public neoliberal narratives of the small state and efficient markets, Paulson sought from Congress exceptional powers of sovereign debt creation and wealth transfer from tax-payers to private banks.

> "The Secretary is authorized to purchase, and to make and fund commitments to purchase, on such terms and conditions as determined by the Secretary, mortgage-related assets from any financial institution having its headquarters in the United States." (from the original 5 page draft of the Troubled Assets Relief Program, 2008)

As US Federal Reserve Chairman Ben Bernanke said in 2008 after Lehman's collapse, the risk was that, without immediate, extreme intervention, 'there will be no economy on Monday'. One wonders what kind of crisis would generate an immediate intervention to prevent the possibility of there being 'no biosphere' next century.

Prior to the GFC, explicit attempts to move economic theory beyond the unrealistic assumptions of neoclassical equilibrium had been almost exclusively directed at financial price phenomena with the intention of developing profitable trading strategists, but in the wake of the crisis, the Hayekian vision of the Market as complex system spontaneously evolving in far-from-equilibrium conditions has arguably come into its own in the sphere of central banking and the management of systemic risk, a move which while something of a paradox given Hayek's hostility to the central bank, merely follows the refounding of risk management in the Hayekian ontology of resilience, 'tipping points', and epistemic limits to prediction that had already been accomplished in the spheres of adaptive environmental management, critical infrastructure security, counter-terrorism and disaster response (Walker and Cooper 2011).

The extraordinary resilience of neoliberalism post-crisis, in my view, is partly due to its metaphorical shift from equilibrium physics to biological complexity. Among neoliberals these days, it is almost de-rigeur to appeal to the evolutionary complexity sciences these days, whether appropriately awed by hedge funds and their breathtaking productivity of 'financial biodiversity' (Lo 2004) or fancifully conflating banks with 'species', a portion of which are inevitably doomed to a socially

useful extinction if only dinosaur governments would stop getting in the way (Ferguson, 2009). The lesson is clear, the financial Market is an extension of the promethean complexity of the biosphere, and as its moments of destruction are inevitably linked to its creative spontaneity. Consequently the financial crisis is not a call for the reregulation and subordination of finance to serve social goals (for example, the preservation of the biosphere as the founding condition of human existence), just an ordinary 'outlier' event in a system whose complexity is too complex for any human mind to master.

Given the prevalence of this soporific Hayekian meme, there was something refreshing in the study of several experts in the mathematics of network topologies, (Vitali et al 2011) whose analysis of newly available cross-ownership data of forty three thousand transnational corporations, led them to identify a 'super-entity' of 147 supra-national finance corporations at the core of the global economy. On their analysis, these banks and funds exert a profoundly concentrated degree of control over the global network of corporations in the 'real economy'. Indeed, according to their analysis, "network control … is much more unequally distributed than wealth. In particular, the top ranked actors hold a control ten times bigger than what could be expected based on their wealth." (2011:6). The release of the report co-incided with the peak of the Occupy Wall Street protests against the increasing convergence of financial and political power in the aftermath of the financial crisis. Journalists picking up the story sought the views not, as one might expect, of economic historians or political theorists but rather exponents of the mathematics of complexity theory. One of these was well-connected financial insider George Sugihara, who while admitting that it was "disconcerting to see how connected things really are", nevertheless brought the gravity of complexity science to bear, arguing that the study of was "strong evidence that simple rules governing TNCs give rise spontaneously to highly connected groups", and assuring us that there is no point worrying about the increasing concentration of political power in a few highly-leveraged financial behemoths, as "such structures are common in nature" (quoted in Coghlan & McKenzie, 2011).

This was a reference to 'power laws', a staple of the Santa Fe 'complexity' school of financial economics. Sugihara's common natural structures, however, rather trace back to the social sciences, and to one of the founding neoclassical economists, Vilfredo Pareto, who developed a logarithmic formula to describe the 'natural fact' that "in all countries and at all times the extreme distribution of income and wealth follows a power law distribution" (Farmer and Geanokoplos, 2008). For Pareto, inequalities of wealth naturally coalesced around a distribution wherein the wealthiest 20% of the population control 80% of wealth, a distribution which while alarming on the surface, would be something of socialist utopia in comparison to contemporary America. According to a detailed study by the economic sociologist William Domhoff (2013), the closest the US came to the Pareto distribution between 1922 and 2010 was in 1976, when the top 20% owned only 80.1% of total wealth and the rest 19.9%. This was not the least, but the *most* equitable wealth distribution in the surveyed period: by 2010, as a result of the tax cuts for the rich, union busting and financialisation of the US economy post-Reagan, 88.9% of the wealth was concentrated in the top 20%, with the bottom 80% of people competing for the remaining 11.1%. The 'Pareto Principle' is widely cited is a prelude to the discovery of power laws, which are held to have universal application in theorizing extreme deviations from Gaussian probability in events such as earthquakes, financial crises, and tellingly for our narrative, extinction events (Sole and Manrubia, 1996).

Who will buy the rain?

In 2008 Canopy Capital, a London based private equity firm, purchased the rights to market the ecosystem services of the Iwokrama nature reserve, a protected tract of rainforest in the Guyana Shield. While the firm and the government of Guyana declined to publicize the terms of their agreement, nor to clarify to the forests indigenous owners by what sovereign power did the state first exclusively possess and then denationalize these rights, it was noted that these ecosystem services included the rainfall production, water storage, and weather moderation provided by a 1432-square mile patch of rainforest. Canopy Capital suggested it was looking at marketing ecosystem services through an 'Ecosystem Service Certificate' attached to a 10-year tradable bond, the interest from which will pay for the maintenance of the Iwokrama forest.

On the Australian leg of his TEEB world tour in 2010, Pavan Sukhdev put up a slide which showed a relief map of the South American continent, and demonstrated the necessary dependence on farmers in the temperate crop growing regions of the continent on the rainfall generated by the tropical rainforests of the tropical north. Noting that the 'Amazon Rainforest Water Pump' puts 20 billion tonnes of water in the atmosphere, some of which falls on the in the Rio Plata Basin, Sukhdev posed the rhetorical question "what does the granary of Latin America pay for its freshwater?". As your present author, who was in attendance, happened to be puzzling through the problem of how Canopy Capital would generate the income to meet the coupon payment on its rainforest bonds necessary to attract private investment, it seemed that Sukhdev had provided the answer. When I asked him if he knew how Canopy Capital intended to exclude non-paying farmers from receiving rainfall, he was merely irritated and called for the next question. However, as Canopy Capital's website darkly hints, recalling the disastrous social triage effected by the water-privatizations imposed by the IMF and the World Bank upon Bolivia, '[i]f we continue not to pay for this public eco-utility, its services will simply be cut off' (Canopy Capital, 2013). The financialisation of the biosphere is at this point but a speculative project to acknowledge the desperate need for investment in conservation and restoration in such a way as to disarm any radical critique of corporate capitalism in its contemporary finance dominated expression. 'Ecosystem services' abandons the potentially radical point of view of earlier conservationism, which understood ecological breakdown as the result of the dominant economic model of permanent growth in conditions of presumed market equilibrium. The implication that economic theory and practice would need to accept that the 'economy' was a subset of the biosphere, and the recognition of this would require a reformulation of economic doctrines so that they were subordinate to ecology, no longer in flagrant contradiction with the biophysical sciences, has been neutralised . Something almost the reverse has happened, a process in which ecologists themselves have played an essential part. The political effects of the collapse of the distinction between money and life catastrophic naturalisation of financial crisis and the speculative financialisation of ecological catastrophe.

In the wake of the 2008 financial crisis, no serious reform of the liberalised sphere of transnational finance has been contemplated: the socialization of the

speculative losses of private banks in the form of government debt, bailouts and austerity measures has rather furthered the concentration of wealth in the very banks at the centre of the crisis, banks which are also key players in the discursive construction of markets for ecosystem services. As evidenced by the ongoing global economic crisis, a crisis which has itself undermined the utopia of an effective market-based response to climate change, capital markets are not capable of self-regulation, much less of determining the 'optimal' mix of species and ecosystems composing the biosphere. Just as the environment of national economic policy is increasing subject to the power of private finance capital and their alumni in central banks in and through crisis, increasingly the environment of the 'environment' is finance.

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